



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 10/655,690 | 09/05/2003 | Nace Layadi | CS02-023 | 6493 |

7590 03/26/2004

GEORGE O. SAILE
28 DAVIS AVENUE
POUGHKEEPSIE, NY 12603

| |
|----------|
| EXAMINER |
|----------|

LEE, CALVIN

| | |
|----------|--------------|
| ART UNIT | PAPER NUMBER |
|----------|--------------|

2825

DATE MAILED: 03/26/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/655,690

Applicant(s)

LAYADI ET AL.

Examiner

Lee Calvin

Art Unit

2825

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-45 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-45 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 05 September 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. ____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 2.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: ____.

OFFICE ACTION***Claim Rejections - 35 U.S.C. § 103***

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1-45 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Shields et al* (US 6,214,742) in view of *Merchant et al* (US 6,410,986).

a) *Shiedls et al* discloses a conventional process for forming a metal interconnect over a layer of glue material and a layer of barrier material having a thickness, comprising the steps of:

- depositing a dielectric layer **108** over an electric point of contact (comprising aluminum), being covered with an ARC layer **110**, on a semiconductor substrate **102** [Fig. 1A and col. 1]
- forming an opening that penetrates the dielectric layer and the ARC of the contact [Figs. 1B-1C]
- depositing over the dielectric layer a barrier layer **116** “formed from a material such as TiN, Ti, TaN and TiW or combinations of these materials” [col. 2, ln.15]
- depositing a tungsten layer **118** over the layer of barrier material [Fig. 1D]
- removing excess material from the dielectric layer [col. 2, ln.21]

Since *Shields et al* disclose a Ti/TiN barrier structure, *Shields et al* inherently teaches a layer of barrier material over a layer of adhesion material.

b) However, *Shields et al* does not disclose depositing over the layer of adhesion layer a layer of barrier material, that comprises first and second layers of barrier material separated by a central layer of adhesion layer. *Merchant et al* discloses the same process for forming a metal interconnect over a layer of glue material and a layer of barrier material having a thickness, comprising the steps:

- depositing over a dielectric layer an adhesion layer **30** [Fig. 2] (or layer **52** in Fig. 3)
- depositing a layer of barrier material **38** over the adhesion layer
- depositing a tungsten layer **40** over the layer of barrier material [col. 1]

Merchant et al further discloses a multi-layer structure Ti/TiN/Ti/TiN [Fig. 5] having a well-known layer of barrier material comprising a first (or lower) barrier **86** and a second (or upper) barrier **90** separated by a central adhesion layer **88**.

It would have been obvious to one of ordinary skill to have modified the process of *Shields et al* by utilizing a multi-layer structure Ti/TiN/Ti/TiN for the purpose of exhibiting improved stress accommodation, mechanical stability and resistance to electromigration [col. 4, ln.7 in *Merchant*].

c) In re claims 7-8, 11-27, 34-38, and 44-45, since *Merchant et al* suggests that the thickness of each individual layer within the multi-layer structure is closely equal [please compare all glue/barrier layers in Fig. 3-5], *Merchant et al* inherently teaches that either the first or the second barrier has a thickness being equal to between about 0.40 and 0.60 of a total thickness of a layer of barrier material (i.e., thickness of either one of the barriers equal to half of the two-layer barrier).

d) *Merchant et al* suggests [cols. 3-4] each layer within the multi-layer structure being significantly thinner --on the order of 100-300Å--(which is within the claimed ranges of the layers' thickness, found in claims 5, 9-10, 15, 17-19, 22, 24-27, 32, 38, and 42).

Any inquiry concerning this communication from the Examiner should be directed to *Calvin Lee* at (571) 272-1896 from 7:00 to 17:00 (Monday-Thursday). If attempts to reach the examiner by telephone are unsuccessful, Art Unit 2825's Supervisory Patent Examiner *Matthew Smith* can be reached at (571) 272-1907.

Any inquiry relating to the status of this application should be directed to the Group receptionist whose telephone number is (703) 308-0596. The fax phones are (703) 872-9318 for regular communications and (703) 872-9319 for After-Final communications.



March 9, 2004


CARIDAD EVERHART
PRIMARY EXAMINER